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ABSTRACT

The act of composing is best described as a set of distinguishable processes that interact. There are four methods for researching these processes: (1) behavior protocols, in which subjects are observed but are not asked to report their thought processes verbally; (2) directed reports, in which subjects are asked to explain how they performed a task; (3) directed reports, in which the subject is asked specific questions while performing a task; and (4) thinking aloud protocols, in which subjects report on anything they are thinking while performing a task. These process tracing methods are better than input/output methods because they can pinpoint difficulties when the writer encounters them, and they offer valuable opportunities for scientific exploration. In addition, there are aspects of writing that are difficult to observe without these methods. Three major objections have been raised about the use of verbal reports as data: verbal reports are unreliable because people are not conscious of their cognitive processes, reporting them verbally distorts them, and verbal reports are incomplete and not objective. It is interesting that verbal protocols are singled out for criticism on the grounds of incompleteness, since they are characteristically more complete than most other methods to which they are compared. (HTH)

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Uncovering Cognitive Processes in Writing: An Introduction to Protocol Analysis*

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Writing is a marvelously complex activity which allows writers great freedom of choice at many levels--from the choice of topics to the choice of tenses. Writing research is also a complex activity which allows the researcher great freedom of choice in research method and level of analysis--from the study of the highest levels of planning to the lowest levels of linguistic structures. The recent very exciting surge of research on writing has involved many methods. The developmental research of Bereiter and Scardamalia, and of Graves, has already yielded exciting results and seems certain to continue to do so. Odell's method of collecting retrospective reports from adult writers also seems extremely promising. Gould and Matsuhashi have focused on the pauses observed during writing. Our own preoccupation has been with protocol analysis.

In this paper, we will discuss the place of protocol analysis in the arsenal of available writing research methods. In addition, we will try to differentiate protocol analysis from other closely related methods with which it is sometimes confused.

To provide context for this discussion, we must first say something about the nature of writing. We can't fully appreciate the relations among the research methods without first discussing the subject matter to which they are applied.

A Cognitive Process Theory of Writing

A theory of the writing process, such as the one sketched here, attempts to isolate those key features of the process that promise broad explanatory power and which are able to account for the way

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people actually behave as they write. If we view writing as a cognitive process, then, four characteristics stand out:

I. The act of composing is best described not as a sequence of stages, but as a set of distinguishable processes which the writer must orchestrate in the act of writing.

A model of this process, shown in Figure 1, suggests in diagramatic form the structure or organization of these processes as we have seen them. Notice that the model specifies three main elements which must interact:

A. The task environment. This includes everything outside the writer's skin including the assignment or exigency for writing, the audience, and eventually the written text itself. It is important to note that no matter what Rhetorical Problem is actually presented to the writer, what finally matters will be the problem the writers represent to themselves in the act of composing (Flower & Hayes, 1980).

Insert Figure 1 about here

B. The writer's long term memory. This includes not only the writer's knowledge of the topic, but of writing plans, conventions, genre, rhetorical problems, and so forth. Again, what counts in writing is not what the writer may be said to know, but what he or she is able or chooses to draw from memory during the act of composing.

C. The writing processes. These are the major thinking processes which writers employ in complex ways during the act of composing.

PLANNING is generating content, organizing it, and setting up goals and procedures for writing. We see PLANNING as a very broad activity that includes deciding on one's meaning, deciding what part of that to convey to the audience, and choosing rhetorical strategies. In short, it includes the whole range of thinking activities which are required before we can put words on paper. It is important to note that

1. PLANNING goes on throughout composing, and
2. The plan may not be encoded in a fully articulated or even in a verbal form. (Plans may be visual images.)

TRANSLATING is the act of expressing the content of PLANNING in written English. Although one can reliably distinguish when writers move from PLANNING (which may produce notes and doodles) to TRANSLATING or the attempt to produce prose, this does not mean that writers have a fully formed "meaning" which they simply "express" in words. Rather they have some more or less developed representation encoded in one form. The act of TRANSLATING it to another form, that is, written English, can add enormous new constraints and often forces the writer to develop, clarify, and often revise that meaning. For that reason, the act of TRANSLATING often sends writers back to PLANNING. Often these processes alternate with each other from one minute to the next.

REVIEW is the act of reviewing both written and mental ideas in order to evaluate and/or revise them. Some REVIEWS are undertaken self-consciously either in the midst of composing and at the end of a draft. Some REVIEWS simply interrupt the writing process when an error or mismatch is spotted.

The MONITOR is the executive of the writing process which determines when to switch from one writing process to another, e.g., when one has generated "enough" ideas and is ready to write. The MONITOR may function differently from writer to writer and from writing task to writing task. Some people move into TRANSLATION as soon as possible in writing a paper, while others won't write a word until they are reasonably certain that PLANNING is complete. Further, a writer undertaking an easy task, e.g., a short letter, may do little or no PLANNING before writing the first sentence, while the same writer undertaking a difficult task, e.g., a philosophical treatise, may PLAN for months before writing a word.

II. Writing processes are highly embedded. They are not constrained to be used in a fixed sequence, such as PLAN, TRANSLATE, and REVIEW. Rather, they are like a tool kit. The tools may be applied in any order which the job demands. For example, a writer in the act of editing may discover an inadequate transition between sentences. To remedy this situation, the writer may call on the PLANNING and TRANSLATION processes to insert new sentences into the text which will smooth the transition.

III. Writing is a goal directed process. A major part of composing is spent in developing both global goals for affecting an audience and developing ideas and more local goals and plans which guide the act of writing. Both the quality and quantity of these goals appear related to the ability of the writer. They provide logic and coherence to the entire process, even when writers perceive their own experience as chaotic and unpredictable.

IV. Writers not only implement goals by creating networks of supporting subgoals, but at times they discover major new goals through insights triggered by the act of writing. Writing to achieve one objective then may lead spontaneously to new goals and perhaps to a radical redirection of the writer's efforts.

The conditions under which these new goals are created suggests a relation to the phenomenon of incubation (see Simon, 1966). The new goals depend on intensive preparation, that is, on knowledge gained during earlier writing efforts (see Wallas, 1926), and they appear, welcome but unexpected, while the writer is pursuing a different goal. Thus, while writing is a goal-directed activity, it isn't necessarily constrained by the goals the writer starts with. An important aspect of the writer's creativity is the ability to create new goals during writing.

Since this theory and its supporting evidence are discussed at greater length elsewhere, let us sum up this discussion by saying that these four points of a cognitive process theory attempt to state the results of our research for the past few years in the form of testable hypotheses about key features of writing as a cognitive process. They are intended to provide for us, as we hope they will for others, a springboard for further research.

Methods for Studying Writing

Writing research methods can be divided quite naturally into two groups: the input-output methods and the process tracing methods.

Researchers using input-output methods study the relations between inputs, that is, factors which influence the writer such as the assignment, the writer's prior knowledge, developmental stage, etc., and the written product--the output. Researchers using these methods do not attempt to observe writing processes directly, that is, they do not observe what the writer does during the act of writing.

Many of the standard procedures of experimental psychology are of the input-output type. An example would be a study in which subjects are given a sequence of problems which vary in difficulty (the inputs) and the researcher measures the number of correct answers (the outputs). An excellent example in the field of literature is Lowes' famous study of Coleridge (1927). Lowes was able to demonstrate a striking relation between Coleridge's reading (the inputs) and his poetry (the output).

While input-output studies do not involve direct observation of writing processes, researchers who do such studies are often very interested in making inferences from their data about writing processes. Lowes, for example, was able to draw conclusions from his study about the processes of invention which Coleridge used in writing "Kubla Khan."

In an impressive sequence of studies (1979, 1980a, 1980b) Bereiter and Scardamalia have studied the impact of the writer's developmental stage on the written output and have derived a number of important inferences about writing processes.

Process Tracing Methods

If we attempt to look more directly at the processes by which people transform input into output, then we are using process tracing

methods. There are four categories of process tracing methods we will need to consider:

1. In behavior protocols, we record what subjects do while they perform a task but we do not ask them to report their thought processes verbally.
2. In retrospective reports, we ask subjects to tell us how they performed a task after the task has been completed.
3. In directed reports, we instruct subjects that we are interested in certain aspects of task performance while they are performing the task.
4. In thinking aloud protocols, we instruct subjects to report on "anything they are thinking" while performing the task.

These methods have a long history of application both in psychology and in English. Introspectionist psychologists (see Humphrey, 1951) trained subjects to report on very well specified aspects of their mental states while performing a variety of tasks. Thus, the Introspectionists used directed reports.

Ruger (1910) studied the solution of mechanical puzzles by watching people as they solved them and by recording the running comments of the subjects as they worked. Ruger's method, then, combined behavioral and thinking aloud protocols. Claparède (1917) strongly advocated use of "thinking aloud" protocols to study problem solving processes.

In both psychology and English, retrospective reports have been used to shed light on creative processes (Plimpton, 1965). Ghiselin (1952) has compiled numerous retrospective reports by artists, musicians, and writers about their creative processes. Janet Emig (1972) has pioneered the use of process tracing methods in the study of writing. Perl (1978) and Pianco (1979) have also made very valuable contributions to the study of writing through process tracing methods.

There has also been a long history of controversy surrounding these methods. In this section, we will discuss the reasons for and the reasons against using process tracing methods.

There are three very compelling reasons for wanting to use process tracing methods.

1. Process tracing methods tell us about process in a much more direct way than do input-output methods. For example, we can pinpoint students' difficulties much more readily if we watch while they are struggling with problems than if we try to infer the problems from errors they have made in their final answers.
2. Because the data they yield are very rich, process tracing methods offer us valuable opportunities for scientific exploration. For example, a thinking aloud protocol of a writer at work may yield 15 pages of comment for every page of written text. Reading through the protocol is an occasion for discovering many things about the writing process that we didn't suspect leforehand.

3. There are some aspects of process which are very difficult to observe without process-tracing methods. For example, process tracing methods show us that the order in which writers generate the ideas for writing a paper is very different from the order in which these ideas are presented in the finished paper. If we look only at the finished paper, that is, the output, it may be difficult or impossible to study the order of idea generation.

Criticisms of Process Tracing Methods

While behavioral protocols have generally been favorably received, a number of concerns have been voiced about the other process tracing methods. These concerns center on the use of verbal reporting. Three major objections have been raised to the use of verbal reports as data:

1. Such reports are not valid because people are not conscious of their cognitive processes.
2. Even if people were aware of their cognitive processes, reporting them verbally would distort them.
3. Verbal reports are incomplete.
4. Verbal reports are not objective and therefore can't be used as scientific data.

Nisbett and Wilson's widely read review, "Telling More Than We Can Know: Verbal Reports on Mental Processes" (1977), provides a good starting point for our discussion of the first two of these objections. Looking at experimental studies of attitude change, Nisbett and Wilson found that often the subjects in these studies were not aware of certain affective and/or perceptual processes, particularly ones that lead

to judgments and changes in attitude. Nevertheless, when asked, for example, "Why did you choose that detergent?" or, "Why did you fail to use contraceptives?" these subjects were able to provide causal explanations based on reasonable inferences, without necessarily consulting or knowing their own processes. Furthermore, these inferences about the causes of their attitude change were often wrong. In other words, although subjects were able to report the result of their decision processes and give an after-the-fact rationale for it, they were often unaware of the process itself. Therefore, asking a writer why she followed one train of thought rather than another may produce a reasonable but fabricated answer. Nisbett and Wilson concluded that subjects are generally not aware of their own processes. Rather, when they are asked to describe their mental processes, they describe what they believe their mental states should have been--not what they actually were.

Nisbett and Wilson's claims have been analyzed in a careful review of the literature by Ericsson and Simon (1980). Ericsson and Simon confirmed Nisbett and Wilson's claims for some kinds of verbal reports but not for others. In particular, they found that Nisbett and Wilson's claims did not apply to concurrent verbal protocols. Ericsson and Simon have proposed a model of verbal reporting which is consistent with all of the data reported in the literature, including that reviewed by Nisbett and Wilson. They postulate that when subjects perform a task such as mental multiplication in their usual way, some of the information involved in performing the task, but typically not all of it, is attended to and enters short term memory.

If subjects give a concurrent verbal report of their mental processes--that is, if they try to say how they are performing the task while they are performing it--the consequences will depend on the nature of the task and on the nature of the report.

Ericsson and Simon specify three experimental situations in which verbalizing could go on.

1. In the first situation, the subjects report only information which they normally attend to while doing the task. The feature which distinguishes this situation is that the information is already in verbal form before it is reported. Imagine, for example, that the subject is trying to solve the anagram CLEAM. The subject might report, "Let's see, meals, no. Alms, no. Calms, CAMEL!" These proposed solutions are already in verbal form before they are reported. A number of studies have shown that merely adding audible expression to such verbal information has no observable effect on the performance of the task.
2. In the second situation, the subjects are also reporting only information which they would normally attend to while doing the task. However, in this case, the information is not already encoded in words. It may be encoded as visual, or motor images or in some other form. As an example, imagine trying to describe over the phone what you were doing while buttoning a button. The monolog might proceed as follows: "Well, first I'm taking hold of the button with the thumb and forefinger of my right

hand, and the button hole with the same two fingers of my left hand. Then I sort of open up the button hole with my left thumb and...." Clearly, describing this action while doing it is going to take longer than just doing it. In any task where reporting requires subjects to translate non-verbal information into verbal form, doing the task with a verbal report may be slower than doing the task without one. However, there is no evidence in situations of this kind that verbal reporting changes the performance of the task in any other way. That is, even though processes are slowed down, their course and sequence are unchanged.

3. In the third situation, subjects are asked to report information which they would not normally attend to in performing the task. They may be asked, for example, to report on their motives, or to justify their decisions. To understand the effects which this sort of reporting could have on task performance, imagine that you are participating in a study on long division. The experimenter wants you to divide 248 into 1336 in your head and to tell him every time you notice an odd number. Your report might go something like this: "248 into 1336 is about 5, so five times 248 is--oops, 5 is an odd number--now where was I? Is there something important about odd numbers in this problem? Oh, yeah, 5--that's an odd number--well...." Asking subjects to report information which they would ordinarily not have attended to in performing a task can seriously disrupt task performance.

The situations described above involve people giving concurrent verbal reports--thinking aloud while they are performing the task. If, however, subjects give retrospective accounts after the performance, the Ericsson and Simon model would predict that much of the information brought into memory during performance would be lost. And the longer the interval between performance and report, of course, the larger the amount of information that is likely to be lost.

One of the most pervasive factors causing loss of information from memory is interference--a fact may be confused with other information either before or after and hence lost. A second factor which may be especially important in forgetting associated with writing tasks is the Zeigarnik effect discovered by Gestalt psychologists. Essentially, the Zeigarnik effect is the tendency for people to forget goals and subgoals once they have been accomplished. Investigation of the Zeigarnik effect was triggered by an observation made by a group of Gestalt psychologists in a Berlin restaurant. Impressed by their waiter's success in remembering their orders, they were surprised that when they questioned him after they had paid their bill, he no longer had any memory of what he had served them.

During writing protocols, we have observed writers struggling mightily with word choice and word order in writing a particularly difficult sentence. When we asked them later about the difficulties they had had with that sentence, they denied them. "It just came to me," they said, "no problem." The writers weren't lying. It's just that the delicate structure of goals and subgoals erected to construct

the sentence was destroyed when the goal was accomplished. The Zeigarnik effect acts to clear away information when it is no longer needed.

The social situation involved in being an experimental subject may well affect the kind and the amount of information people will report. Subjects participating in studies typically try to be cooperative. Their cooperativeness may sometimes have unfortunate side effects when they are asked about information which they have forgotten or failed to notice. For example:

1. Subjects often try to please experimenters. If asked, "Did you do any planning?" or, "Do you usually outline when you write?" subjects will say, "Yes," meaning, "If you think I should have, I did."
2. When subjects don't know the answer to a question, they may well try to help the experimenter by figuring out what the answer should be. Nisbett and Wilson found that when people chose among identical clothing items on a rack, they showed preferences for certain positions. When subjects were asked why they made a particular choice, they never referred to the position preference of which they were unaware. Instead, they gave the sorts of reasons that one would expect to be important in such decisions--imagined differences among the identical items.
3. In order to understand their own behavior, subjects will probably draw on conventions or schemas they know about. If they believe in incubation--and know the term--they may

well think they used it. We will never know whether it actually occurred or not. If they experienced it, but don't know the concept, chances are it won't be reported.

As we noted above, the Ericsson and Simon model not only accounts for the literature they surveyed, but also for the literature surveyed by Nisbett and Wilson. Most of the studies cited in the Nisbett and Wilson review either involve retrospective reports or ask the subjects to report information which they would not normally attend to in the course of performing the task. Accurate reports of mental processes would not be expected in such studies. In fact, none of the studies reported by Nisbett and Wilson violates the predictions of the Ericsson and Simon model.

Summary

A. In concurrent verbal reporting:

1. If the subject is reporting memory traces which are verbal, then reporting appears neither to change nor to slow down task performance.
2. If the subject is reporting non-verbal memory traces, then reporting may slow task performance but does not appear to change its course or structure.
3. If the subject is asked to report information which would normally not be attended to while performing the task, e.g., tell me every time you think of an odd number, then reporting may modify the usual sequence of mental processes involved in performing the task.

B. In retrospective reporting, subjects are likely to forget some of the information about processes which was available during task performance.

C. If subjects are asked to report on information they have forgotten, as they may be asked to do in retrospection, or to report on information they haven't noticed, as they may asked to do in directed reporting, they may invent answers which do not describe the processes which actually occurred.

Having discussed the theory of writing and the theory of verbal reports, we are now in a better position to evaluate the merit of thinking about protocols as a method for studying writing.

Thinking aloud protocols share the three advantages of process tracing methods we mentioned above. That is:

A. They provide very direct evidence about processes.

B. They yield rich data and thus promote exploration. And

C. They can detect processes which are invisible to other methods.

These advantages are important in the study of writing. Because writing involves a complex integration of processes, and because it extends over considerable periods of time, writing presents special problems for analysis by input-output methods. When an activity consists of a complex mixture of processes, it is very difficult to figure out through input-output analysis what each process is contributing. This is what Minsky (1963) calls the credit assignment problem. The problem is that the

same qutput might have been caused by many different combinations of processes. Thus direct observation is important for determining which combination of processes actually occurred.

Research and theory in writing is in a very early stage of scientific development--a stage in which exploration must naturally play a very major role. Because of the rich data they provide, verbal protocols can speed exploration and thus help to set directions for future research.

Verbal protocols have been subject to some undeserved criticism because they have been confused with other methods of verbal reporting. Nisbett and Wilson's criticisms of verbal reporting methods are appropriately applied only to some of the methods. Retrospective reports are likely to lose information and directed reports are likely to distort the process being studied. However, thinking aloud protocols have neither of these problems. Ericsson and Simon (1980) found no evidence that thinking aloud protocols change the course or structure of the task being studied. Rather, they concluded that thinking aloud protocols reveal the structure of psychological processes quite accurately.

A common criticism of protocols is that they are incomplete. In fact, they are incomplete. Many of the psychological processes which we depend on every day are completely unconscious and therefore will not appear explicitly in thinking aloud protocols. For example, when we read, we are conscious of the topic being discussed and sometimes of style, but we are never conscious of the processes by which we retrieve the meanings of the words we see on the page from memory.

Some processes are conscious at times and unconscious at other times. For example, some processes may enter consciousness only when they encounter difficulties. We may be unaware that we are doing grammatical analysis as a part of reading except when we run into especially difficult sentences. Some processes may be conscious when we first acquire them, but become unconscious as we become more expert. For example, inexperienced writers may be very aware of their efforts to take the audience into account, while experts who exercise the same processes may do so so automatically that the processes are no longer conscious.

It is interesting that verbal protocols are singled out for criticism on the grounds of incompleteness, since protocols, while not complete, are characteristically more complete than most of the other methods with which they are compared. For example, a protocol of a writer in action typically provides us with many more clues and with clearer clues to writing process than does the most careful input-output analysis (e.g., analysis of the text that the writer produces).

Protocols provide us with a very valuable window onto our thought processes. Though the scope of that window is not infinite, it is wider than most of the other windows available.

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